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Comparison of the Storage Life of Vacuum-Cooled and Ice-Packed Lettuce

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Comparison of the Storage Life of Vacuum-Cooled and Ice-Packed Lettuce

Introduction

The length of time that lettuce can be held under refrigeration is of considerable practical significance. Commercial shipments are often 2 weeks in transit and sometimes 3 weeks. A considerable quantity of lettuce is used on board ship and at overseas military bases or commercial markets entailing shipping and storage periods of 3 to 4 weeks. At the request of the Naval Supply Depot of Bayonne, N. J. tests were begun on the storage of lettuce at the New York Laboratory in 1944 and were continued in 1945. The results were published by Bratley in H. T. & S. Office Report 161. In preliminary work he found that ice-pack lettuce yielded more edible lettuce than dry-pack but it was more prone to develop infections of soft rot during the 6 weeks' storage at 34° F. In additional tests, various wrapping materials such as cellophane, waxed paper, vegetable parchment paper, and newsprint gave about the same results and non-wrapped lettuce stored as well as wrapped lettuce. The most significant finding was that only a moderate lowering of storage temperature greatly extended storage life. Western-grown lettuce was held twice as long at 34° F. as at 43° and tests on eastern-grown lettuce indicated that 32° was much better than 36°.

With the advent of vacuum cooling in 1948 and its growth in use, dry-pack lettuce is available even in warm weather in markets as far away from the shipping point as New York or Boston. Tests on storage life of lettuce were resumed in 1953 at the New York Laboratory because of the continued interest in the problem and the questions raised regarding the effect of vacuum cooling on the keeping quality of lettuce.

Shipping records

Through the cooperation of the Western Growers Association, lettuce was made available for storage tests from 8 pairs of test cars shipped from California to New York from January 21 to June 2, 1953. One car of each pair contained ice-packed lettuce in crates, the other was loaded with carton-packed lettuce which was cooled by vacuum equipment. The lettuce in the test packages in each pair of cars was comparable as to field origin and time of harvest. The shipping data for the 16 cars are given in tables 1 to 4. Seven of the cars were shipped from El Centro, 5 from Salinas, and one each from Brawley, Calexico, Holtville and Watsonville, California. Two cars were diverted to Philadelphia, while the remaining 14 cars were unloaded in the New York City area. Eight to 13 days elapsed between the time the cars were shipped and the start of unloading, with an average period of 9 days per car.

The number of crates and cartons varied in the cars, averaging 333 crates (holding 48 heads per crate) or 542 crates (holding 32 heads each) and 647 cartons (with 24 heads each).

The crates were ice-packed and top-iced in transit. The cartons were vacuum-cooled and were not package-iced or top-iced. The vacuum-cooled lettuce was shipped under half-stage icing (5 cars) or full-bunker icing (3 cars), using various types of services. The fans were in the operating position in six of the cars of cartons and in two the fans were not operated. In the cars with ice-packed lettuce the fans were not operated or non-fan cars were used. Lettuce temperatures were taken by means of hand thermometers prior to unloading. Temperatures averaged 34° F. for top and bottom positions in the cars of standard crates. The average for the cartons was 38° F. at the top and 37° at the bottom. The lettuce temperatures averaged about 3 degrees warmer in the cartons than in the crates.

The varieties of lettuce used were No. 101 (3 tests), Great Lakes (3 tests), and No. 615 (2 tests).

Methods

On arrival at the laboratory 16 of the heads from each test lot were examined immediately. These 16 heads were discarded after the examination and the remainder were stored at either 33° or 38° F. Four lots were stored at 33° and the same number at 38°. The temperature in the 33° storage room ranged from 32° to 34°, and the relative humidity of 85 percent (range 81 to 91%). The temperature in the 38° storage room ranged from 37° to 39°, and the average relative humidity was 83 percent (range 77 to 85%). Sixteen more heads of lettuce were removed after an average storage period of 25 days at 33° or 16 days at 38°. The remaining 16 heads were placed in a 70° room and held for 2 days to simulate a marketing period. The 70° F. holding room temperature ranged from 69° to 70°, and the relative humidity averaged 78 percent (range 70 to 90%). At the end of the 2-day holding period the 16 remaining heads were examined.

At each inspection the heads of lettuce were weighed and all discolored, bruised or wilted leaves were removed and weighed. The decayed leaves were trimmed and weighed separately. At the same time the heads of lettuce were rated for freshness, color, firmness, and marketability (salability). A head of lettuce was rated marketable if removal of decayed or discolored leaves would leave a head that was considered salable without a reduction in price. Marketability ratings were made to indicate the condition of the lettuce after storage for resale. The lettuce consigned to shipboard is trimmed as severely as necessary and any edible portions remaining utilized. For this reason the amount of edible lettuce remaining after trimming was recorded. Samples were cut at each examination to determine the presence

of internal defects which consisted of various types of brown spotting, pitting, and tipburn.

Results

Vacuum-cooled lettuce showed a slight wilting of the outer leaves at arrival and after storage, and the butts at arrival were more pink than those of comparable ice-packed heads. There was slightly less decay in heads of vacuum-cooled lettuce and less trimming waste (by weight) as compared with ice-packed lettuce (see table 5). In both lots of lettuce the decay was confined mainly to the wrapper and outer head leaves, and consisted principally of bacterial soft rot, with some breakdown caused by downy mildew and gray mold. There were generally more leaf defects in vacuum-cooled lettuce as compared with ice-packed lettuce. Whether the difference in the amount of leaf discoloration is significant or may be accounted for by variation in the samples, inspection methods or other factors is not known. The apparent reduction in the number of heads showing internal defects after 2 days' holding at 70° F. is probably accounted for by the fact that tipburn and other internal defects predispose lettuce to secondary decay and some of the heads scored as having internal defects when removed from storage were scored as decay after the 2-day holding period. Similar internal defects were found by Bratley in western-grown lettuce stored 5 to 6 weeks at 33° to 35° and in eastern-grown lettuce stored at 36° but not at 32°.

After trimming the discolored and decayed leaves there was generally more edible lettuce and marketable heads in the vacuum-cooled lots than in the ice-packed lettuce (see table 6). Much of this difference might be accounted for by the fact that 25 percent of the heads of ice-packed lettuce were rated as slightly bruised or showing scorable damage by bruising, while only 10 percent of the vacuum-cooled lettuce was similarly bruised. It might be noted as regards table 6 that trimming at arrival resulted in a weight loss from 26 to 38 percent and while there was a marked reduction in the number of marketable heads in all lots during storage and the 2-day holding period, the reduction in the amount of edible lettuce was substantially less during a similar period.

Summary

As compared with ice-packed lettuce, vacuum-cooled lettuce showed more wilting and internal leaf discoloration, but less decay, and more edible lettuce and marketable heads. Except for more bruising injury in ice-packed lettuce and slight wilting of the vacuum-cooled lettuce, the differences in appearance, decay, edible portion and salability of lettuce in the 2 types of packages were slight. The results also show that after a transit period of 8 to 13 days, 25 days' storage at 33° F. or 16 days at 38° would probably be too long a period for lettuce that must then move through wholesale and retail channels. Under similar conditions, however, enough edible lettuce would be recovered after trimming to probably make it worthwhile for ships' stores or commissary purposes.

Table 1. Lettuce shipping tests 1953 -
and ice-packed crate lettuce

	Test No. 1		Test No. 2	
Refrigeration:	Ice-packed	Vacuum-cooled	Ice-packed	Vacuum-cooled
Car number:	PFE-44598	PFE-47601	PFE-74976	PFE-41052
Shipper:	H. P. Garin Co.	H. P. Garin Co.	American Fr.Gr.	Bud, Inc.
Shipping point:	El Centro, Calif.	El Centro, Calif.	Brawley, Calif.	El Centro, Calif.
Variety:	No. 101	No. 101	No. 101	No. 101
Date loaded:	1/21/53	1/21/53	1/26/53	1/26/53
Railroad service:	Top ice	Half stage, standard refrigeration	Top ice	Half stage, standard refrigeration
Cases per load:	328	648	337	648
Date unloaded:	2/2/53	1/29/53	2/3/53	2/8/53
Commodity temperature at unloading:				
Top doorway:	36°	36°	33°	35°
Bottom doorway:	34°	35°	33°	35°
Remarks:	This car was unloaded at Philadelphia; 1 ft. of ice in bunker reported. Only center half of car had top ice on arrival, channel ice practically none; 1 bad order crate. Slight shift A end.	On arrival fans in "on" position; 1 bad order carton. Principal type of breakage torn sides. Scattered crushed ice under floor racks.	On arrival 4 to 10 inches snow ice on top of load, except 2 stacks A end in which only scattered chunks were noted. Heavy channel icing, except at A end and side walls. Seven packages required recoopering; all made good. Some freezing was noted in top layer of crates affecting 1 to 3 outer leaves.	On arrival fans "on" position, bunkers full. Generally good order load - 2 packages bad order.

Table 2. Lettuce shipping tests - 1953 - California to New York - comparison of vacuum-cooled cartons and ice-packed crate lettuce.

	Test No. 3		Test No. 4	
Refrigeration:	Ice-packed	Vacuum-cooled	Ice-packed	Vacuum-cooled
Car number:	PFE-91802	SFRD-3446	PFE-67723	PFE-47605
Shipper:	C. Freedman	Holmes & Seifort	Farley Fruit Co.	J. Maggio, Inc.
Shipping point:	El Centro, Calif.	El Centro, Calif.	Calexico, Calif.	Holtville, Calif.
Variety:	No. 101	No. 101	No. 615	No. 615
Date loaded:	2/2/53	2/2/53	2/13/53	2/13/53
Railroad service:	Top ice	Half stage, re-ice at El Paso, Rule 247, no salt.	Top ice	Half stage, pre-iced, re-ice daily to capacity.
Date unloaded:	2/12/53	2/10/53	2/23/53	2/23/53
Cases per load:	323	640	338	640
Commodity temperature at unloading:				
Top doorway:	33°	38°	33°	39°
Bottom doorway	34°	36°	33°	41°
Remarks:	Non-fan. On arrival top ice medium to none over bunker stack Channels generally full. Good order car, though there was some crosswise shifting. No serious damage.	On arrival bunkers were empty. Fairly good order load, though there was a slight shift in upper layer, denting a few cartons up to 1 1/2 inches. No serious damage.	On arrival the fans were "off"; some top ice over load except at bunkers. Channels generally full except in bunker stacks, which were only 3/4 full. Bunkers dry, good order load.	On arrival bunkers were full, fans "on" 15 cartons suffered water damage (all accepted in good order).

Table 3. Lettuce shipping tests - 1953 - California to New York - comparison of vacuum-cooled cartons and ice-packed crate lettuce.

	Test No. 5		Test No. 6	
Refrigeration:	Ice-packed	Vacuum-cooled	Ice-packed	Vacuum-cooled
Car No.	PFE-40097	PFE-41474	PFE-91516	PFE-67400
Shipper:	Bruce Church Co.	Bud, Inc.	Harden Farms, Inc.	K. B. Nutting Co.
Shipping point:	El Centro, Calif.	El Centro, Calif.	Salinas, Calif.	Watsonville, Calif.
Variety:	No. 615	No. 615	"Great Lakes"	"Great Lakes"
Date loaded:	2/17/53	2/17/53	5/11/53	5/11/53
Railroad service:	Top ice	Half stage, standard, pre-iced	Initially bunker iced, 20,000 lbs. top ice supplied at origin by shipper	Standard refrigeration, initial bunker icing.
Date unloaded:	2/27/53	2/26/53	5/20/53	5/20/53
Cases per load:	337	648	542	650
Commodity temperature at unloading:				
Top doorway:	33°	38°	35°	37°
Bottom doorway	34°	36°	35°	36°
Remarks:	On arrival top ice medium to trace interspersed. None over bunker stack. Channels 1/2 to 3/4 full near ends of car. Good order car.	On arrival the fans were "on". Bunkers were full. Generally good order car.	Good order load. On arrival heavy top ice and full channel ice. Bunkers 3/4 full. No fans.	Good order load. Three feet of ice in the bunkers; the fans were off.

Table 4. Lettuce shipping tests - 1953 - California to New York - comparison of vacuum-cooled cartons and ice-packed crate lettuce

	Test No. 7		Test No. 8	
Refrigeration:	Ice-packed	Vacuum-cooled	Ice-packed	Vacuum-cooled
Car No.	PFE-60774	PFE-2553	PFE-66695	PFE-47672
Shipper:	Harden Farms, Inc.	Major Distr. Co.	Major Distr. Co.	Major Distr. Co.
Shipping point:	Salinas, Calif.	Salinas, Calif.	Salinas, Calif.	Salinas, Calif.
Variety:	"Great Lakes"	"Great Lakes"	"Great Lakes"	"Great Lakes"
Date loaded:	5/15/53	5/15/53	6/2/53	6/2/53
Railroad service:	Initially iced to half stage at first regular icing station plus 10 tons top ice by shipper.	Pre-iced car. Standard refrigeration; 1% salt (based on amount of ice used at each regular icing).	Initially bunker iced plus 20,000 lbs. of top ice.	Standard refrigeration; 2% salt.
Date unloaded:	5/28/53	5/25/53	6/10/53	6/10/53
Cases per load:	542	656	4 crates of lettuce in a carlot of carrots.	648
Commodity temperature at unloading:				
Top doorway:	35°	43°	35°	37°
Bottom doorway:	36°	39°	36°	36°
Remarks:	The load arrived in N.J. in a fair condition. There was about 10 inches of ice in center, decreasing to none over bunker stacks. Channel ice light and irregular. A bunker 1/3 full, B bunker 1/2 full. No fans. This car was rejected because of decay and diverted to Philadelphia.	Generally a good order car. The bunkers were 3/4 full, the fans in "on" position. A few cartons showed wet spots adjacent to decayed heads.	Fans in "off" position. On arrival top and channel ice were noted. The car appeared in good order.	Fans in "off" position. Though there was a shift of 4 inches in all layers, it resulted in no apparent serious damage. The bunkers were full on arrival.

Table 5. Decay and internal defects in vacuum-cooled and ice-packed lettuce after shipment and storage.

	Heads decayed		Waste from decay		Heads with internal defects	
	Vacuum	Ice-pack	Vacuum	Ice-pack	Vacuum	Ice-pack
	%	%	%	%	%	%
33° F. storage 1/						
Upon arrival after 9 days in transit	2	2	Trace	Trace	6	0
After 25 days' storage at 33° F.	55	55	13	20	31	13
2 days at 70° F. after 25 days at 33° F.	100	97	33	42	10	6
38° F. storage 1/						
Upon arrival after 10 days in transit	3	31	1	11	0	15
After 16 days' storage at 38° F.	47	77	14	32	32	19
2 days at 70° F. after 16 days at 38° F.	88	100	29	40	24	7

1/ Sixty-four heads of lettuce inspected at each inspection date for decay and marketability; a sample of 16 to 32 heads were cut at each inspection to detect internal defects.

Table 6. Edible lettuce and marketable heads in vacuum-cooled and ice-packed lettuce after shipment and storage.

	Edible lettuce		Marketable heads	
	Vacuum	Ice-pack	Vacuum	Ice-pack
	%	%	%	%
33° F. storage 1/				
Upon arrival after 9 days in transit	72	68	100	98
After 25 days' storage at 33° F.	55	56	42	33
2 days at 70° F. after 25 days at 33° F.	47	44	25	20
38° F. storage 1/				
Upon arrival after 10 days in transit	74	62	100	81
After 16 days' storage at 38° F.	67	57	63	58
2 days at 70° F. after 16 days at 38° F.	61	54	47	42

1/ Sixty-four heads of lettuce inspected at each inspection.